



Government of Bengal

Sanitary Board

# Nutrition Committee

RECENT DEVELOPMENTS  
IN FOOD TECHNOLOGY.

F8,3  
N44  
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CALCUTTA  
APRIL, 1944

CFTRI-MYSORE

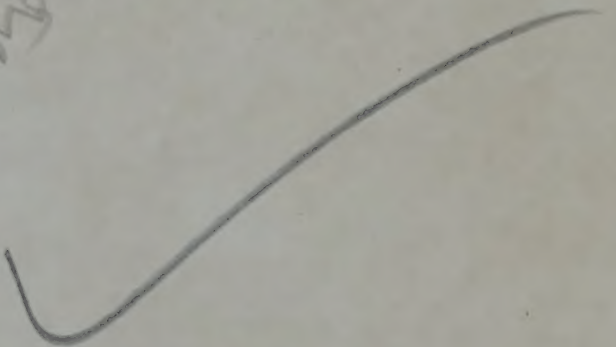


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BRITAIN'S WARTIME FOOD PRODUCTION DRIVE

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IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

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## BRITAIN'S WARTIME FOOD PRODUCTION DRIVE

To understand properly Great Britain's wartime drive for food production it is necessary to know something about the peacetime situation. Great Britain had a population of some 46 million people in 1937 of which 335,000 were actual farmers, and with their workers made up a total of 1,030,000 occupied in agriculture. If the families were added in, less than 10 percent of the population were directly dependent on agriculture. Yet this small number of people produced some 40 percent of the food of 46 million people. It was a great performance, better than in any other country in Europe: one worker fed on the average no fewer than 17 people. But the 40 percent home production was not evenly distributed over all foods; we produced the whole of our liquid milk and potatoes, and half of our meat, but only about 25 percent of our wheat and 10 percent of our butter. British farms are in the main small: more than 80 percent of them are 150 acres or less in area; but the farming units are remarkably stable, being mainly the area of land that one man can adequately supervise. In peacetime the main output of British farms is livestock products, the value of which in recent years was £150 million out of a total value of £220 million for all farm and market garden produce for England and Wales; livestock thus represented 70 percent of the total value, farm crops about 15 percent, and fruit, vegetables and glasshouse produce also 15 percent. Our cold, wet climate imposes a high standard of nutrition, and the quantities of meat eaten were higher than anywhere in Europe.

### Wartime Changes: A new dietary.

When war broke out it was clear that we could not indefinitely continue to import 60 percent of our food, but it was also clear that we could not produce it all ourselves. Our peacetime dietary required about 1.6 acres of cultivated land per head of population, and we had not got more than about 0.6 or 0.7 acre per head. Something could be

added by reclaiming land at present waste or at least non-agricultural, but the possible increase was not great and was more or less offset by loss of agricultural land for aerodromes, camps, etc. Two courses of action were adopted. Our national dietary was changed so as to reduce the consumption of meat, butter, and imported fruit, all of which take up considerable shipping space: correspondingly there had to be an increased consumption of vegetables and potatoes. At the same time the most intensive production of grain, potatoes and vegetables was organized. Of all things national dietaries are the hardest to alter: people are extremely conservative in matters of food, so the change had to come slowly. First of all the dieticians were set to extol the merits of potatoes and vegetables; the nation had to be made 'vitamin conscious'. Here the B B C with its so-called 'Kitchen Front' played a great part. War broke out for us on Sunday, 3 September 1939: 18 weeks afterwards on 8 January 1940, rationing of food began, but at first it was very mild, affecting only bacon, butter and sugar; the cuts were not severe and were hardly felt. Then on 11 March 1940, meat was rationed but not poultry, rabbits, game, fish or meat 'offals', and in any case the allowance was ample; there were always supplies of the unrationed foods. Not till the end of 1940 did rationing much restrict our old food habits; even now (April 1942) we really have nothing to complain about: the weekly ration for an adult includes about  $1\frac{1}{2}$  to  $1\frac{3}{4}$  lb. (according to price) of meat of various kinds, including bacon; 8 oz. of fat (i.e. 2 oz. butter, 6 oz. margarine, 2 oz. cooking fat); 3 oz. cheese (but agricultural and certain other workers and vegetarians have 12 oz.); 8 oz. sugar, 2 oz. tea, 4 oz. preserves (jam, marmalade, syrup, treacle or mincemeat, but not counting honey); milk 3 pints weekly (but extra for children, expectant mothers, invalids, etc.). Tinned and dried foods are rationed on a point system - 24 points are allowed per month and these can be expended in a great variety of ways -

a tin of butter priced at from 1 to 16 points according to its quantity. Eggs are not rationed but allocated; the difference is shadowy - there were 3 per head during March. Fish, however, is not rationed, and is available in moderate quantity; so also are various so-called meat offals, liver, sweetbreads, hearts and game. Moreover, meals in canteens and restaurants do not count ~~any~~ and many of the men have at least one meat meal a day out, as do the children at school. Further, home-produced food does not count.

### New Home Producers.

Many people are now growing potatoes, vegetables, and fruit; they keep poultry to give eggs, bees to produce honey, and rabbits to increase the meat supply; some also keep goats to furnish more milk. All this is a complete addition to our old supplies. This additional home production of potatoes and vegetables has been a very great advantage. It has saved a great deal of transport, which, under present conditions, is extremely important and it has ensured that a large number of households have some at least of their food always on the spot and always in good fresh condition.

From the outset the new food producers were encouraged to grow a variety of vegetables and especially to include any that particularly appealed to them. The B B C arranges weekly talks on the management of the garden, while, in the daily 'Kitchen Front', recipes are given for serving up the vegetables in newer and more attractive forms. So enthusiastically has the call 'Dig for Victory' been accepted that much open unused ground in towns and villages, derelict or half-used fields, parts, forecourts and other patches of land have been dug up and made to grow vegetables and potatoes. Demonstration allotments have been set up and assistance is given in a variety of ways to the beginner.

At mid-March 1942 Mr. Hudson stated in the House of Commons that we now had nearly 1,750,000 allotments practically double the prewar figure, in addition to 2 million to 3 million private gardens, and the allotment holders and private gardeners between them are producing some £10 million to £15 million worth of vegetables. The movement is still spreading, for we have been warned that next winter will be a trying time, and each man must do what he can to grow a reserve of food for himself.

### New Farm Production.

Life is so strenuous, however, and wartime duties such as Home Guard, Civil Defence, Air Raid Protection and Fire Watching are becoming steadily more insistent, that the allotment and garden effort is not likely to expand greatly. For the bulk of our home-produced food we must look to our farms. Our new dietary, allowing for the supplements due to the home garden and allotments, requires less than the 1.6 acres needed by the old one, and in consequence we have automatically been able to increase the proportion of home-grown foodstuffs and to supply considerably more than the 40 percent fed in peacetime: this would have been the result even had no increase in food production occurred.

But alongside of this changed dietary there has been an intensification of food production. Grassland is less productive of human food than arable land and a considerable area has therefore been ploughed up. In peacetime the United Kingdom had 13 million acres of arable land and 19 million acres of permanent grass: at mid-March 1942 Mr. Hudson informed us the figures were ~~xxx~~ reversed and there soon would be 19 million acres of arable land. The additional 6 million acres had gone into a variety of crops: oats had taken about  $1\frac{1}{2}$  million, the wheat acreage had been increased by more than

350,000 acres and the potato crop in 1939 was 30,000 tons over the production of 1938. Production of wheat and 700,000 of potatoes. Vegetables also increased from 2.5 million tons in 1938 to 4 million tons; sugar beet, it was hoped, would be raised by 60,000 acres to the 105,000 which was all the existing factories could cope with.

These great increases in the areas of arable crops would have been impossible but for a large increase in the number of tractors. Here the young countryman's machine-mindedness had been a great advantage. The present generation of young people has been brought up alongside of mechanical devices and thereby gained a high degree of familiarity with them; as children they had mechanical toys; as boys and girls they had bicycles, later on motorcycles and wireless sets and the chance of watching motor cars and tractors dismantled and reassembled at the local garage. So the introduction of the tractor and electric motor on the farm came as a perfectly natural development, and there is little of the wastage due to inattention or wrong use that one sometimes sees in other countries. There are now said to be 100,000 tractors in use in Great Britain and it is further stated that our farms are the most heavily mechanized in Europe. Young women have taken remarkably well to tractor driving and the reserves of woman power in the country are still considerable.

### Milk and Meat Output.

In the last war (1914-18) we also increased greatly our area of arable land and our output of wheat and potatoes but this was done at the expense of meat and milk production, both of which fell off considerably. In this war the situation has been very different. Official figures are not available but it seems clear that there has been practically no reduction in milk output; indeed last December

the official estimate was a reduction of about 3 percent only. Milk has been rationed because consumption rose: according to the Duke of Norfolk it is 25 percent up; more than ever before is earmarked for children and as far as possible steps are taken to see that they get it. The result is that our children will come well out of the war with health unimpaired and not suffering from the malnutrition and deficiency diseases that the Germans are inflicting on so many of their child victims in Europe. The numbers of cattle remain high: there has been some fall in the number of sheep, pigs and poultry, though it will not be difficult to restore these after the war; pigs and poultry in particular multiply very rapidly, and the popular sheep of today are the prolific Border-Leicesters which are usually crossed with a Southdown ram or an Oxford or Hampshiredown to give the type of lamb wanted for the local market. This season, 1942, promises to be one of the most prolific on record; in our flock of 200 breeding ewes at Rothamsted we have already had 2 sets of quadruplets, 18 sets of triplets and many sets of twins. It would be interesting to speculate on the reasons for this: the shepherd associates it with the abundant growth of good grass last autumn when the rams were running with the ewes; on the other hand some of the physiologists do not accept this view. The output of meat has suffered, but there are no official figures to show by how much: probably, however, less than in the last war.

The reduction of imports has greatly affected animal nutrition also: prior to the war we imported about 25 percent of the starch and protein equivalent required by our livestock. Much of this is now unavailable. Moreover, the closer milling of the wheat has reduced the supply of wheat offals to the animals. The ploughing up of the grassland deprives them of much of their protein equivalent

and the arable crops grown instead do not fully supply the deficiency, although they go a long way. Also the arable crops furnish food both summer and winter, while the grass provides a great flush of food in summer and much less in winter. This inconvenience is being mitigated by an extension of silage, in the making of which molasses is used with advantage. Grass drying would have been useful but it was not practicable under war conditions partly through lack of driers and other equipment, partly through shortage of oil fuel on the farm. In consequence of these various difficulties our animals have less protein and starch equivalent than in peacetime and so give lower yields of milk and of meat, and also the meat is not so well finished: it lacks the rich juiciness of the peacetime product.

### New Administrative Organization.

When the war began in September 1939, our agricultural position was certainly in some directions worse than it had been in August 1914 when the earlier war had started. We had fewer agricultural workers and fewer acres under the plough than ever before and our farmers were disheartened and financially handicapped by a series of difficult years. But on the other hand we had developed a good service of advisory officers. County agricultural staffs were in touch also with advisory scientific staffs of chemists, entomologists, plant pathologists, economists and others, who were centred at universities or large experiment stations where adequate appliances would be made available; and the agricultural departments and experiment stations were well staffed with scientists all anxious to do their best to help in the war effort. At the outset the Ministry of Agriculture decided to set up War Agricultural Committees in each county and to give them extensive powers of controlling the operations of the individual farmers.

Each man is told how much grassland he must plough up; if he has not got the implements the work will be done for him and charged to him. He is also told what he should grow, though considerable latitude is allowed to ensure the fullest chance of success. A survey has been made of all the farms and they have been graded as A (excellent), C (poor) and B (intermediate). Enquiry is made as to why the C farms are so poor: if it is a case of ignorance and incompetence the farmer can be dispossessed and the land taken over by the War Agricultural Committee; if on the other hand it is due to some mechanical hindrance the Committee has power to put this right. It is gratifying to record that C farms are not numerous and that dispossession has been rare. In many instances useful help has been given and productiveness increased. The War Agricultural Committees have been able to undertake large-scale improvements, particularly drainage, which for some years past have been beyond the power of individual owners. Great Britain practically never suffers from drought (except in the Eastern Counties in spring); our troubles are usually from too much rain and from water seeping down from higher ground and so making the land waterlogged. Drainage schemes on a proper scale effectively raise the productiveness of the land, and a number of them have been put into operation. The Committees have also ploughed up considerable areas of land which had not been cultivated for many years; gorse-covered commons have been converted into potato fields, the commoners' rights, which all ~~xxxx~~ through the ages had prevented cultivation, being waived in the interests of food production. The shortage of grass has stimulated the reclamation and improvement of the so-called 'rough grazings', land which supplies a certain amount of grazing to animals but not enough to justify the expenditure of time or money on it. Methods have been

devised for improving it and covering it into  
 useful material. Then too, supplies of fertilizer  
 and of feeding stuffs are strictly controlled and  
 allocated to the different counties. Thanks to  
 our highly efficient chemical industry we have al-  
 most unlimited supplies of sulphate of ammonia, and  
 to that extent we are much better off than in the  
 last war when nitrogenous fertilizers were very  
 scarce. But we have no such large supplies of  
 phosphates or of potash, and so it has been necess-  
 ary to ensure that these shall be used to the best  
 advantage. The use of potash is restricted to  
 certain crops only: potatoes have a high priority,  
 and, among vegetables, tomatoes and brassicas. So  
 feeding stuffs have to be allocated. Priority is  
 given to milk production, but even so dairy  
 farmers are expected to grow sufficient fodder crops  
 and cereals to provide the first half-gallon of  
 milk per day; they can then obtain concentrated  
 feeding stuffs to increase their output. It is  
 announced, however, that the position will deterio-  
 rate next winter and that farmers must then provide  
 for the first gallon of milk per day.

### How it is Financed.

Agriculture is, however, a business and  
 farmers can increase their food production only  
 if they have the necessary funds. This has been  
 provided by fixing prices which allow a reasonable  
 margin under average conditions of farming. Farm  
 wages have, of course, risen, and now stand at  
 a minimum of £3 weekly for a man, the actual pay-  
 ments being of course higher because of overtime  
 or special duties. Prices of farmers' require-  
 ments have also risen but not inordinately, and  
 they are in any case controlled. The prices paid  
 for farm produce take account of these costs and  
 still leave the farmer under average conditions  
 with the possibility of coming out safely.

Farmers under better conditions can, of course, make considerable profits but these are taken by the Exchequer in the form of excess profit tax and income tax. Patriotism has had to replace profit as the motive for high output and fortunately for the country both farmers and farm workers are responding well to the demands made upon them. We are warned that next winter will be the most serious of all the war winters and in particular that the food situation then will be worse than anything yet experienced. But instead of depressing our people this has only stirred them to greater zeal and activity, and everywhere one sees food production in full swing to ensure that, whatever happens, the country will always have sufficient food to be able to continue the fight till victory is attained.

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## THE FUTURE OF FOODS TO COME

Paul H. Willis

President, Grocery Manufacturers of America, Inc.

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War's putting a big squeeze and a fast freeze on many a pantry favorite - to save ships, time, and nutrient. All of which portends a revolution in post-war kitchen arts. This article is Number 4 in the 'Putting Science to Work' series.

Two problems having nothing to do with weapons have vexed soldiers, from Alexander to Eisenhower. They are how to lighten the weight of foods, and how to keep them from spoiling.

Dried buffalo meat made possible long forays into enemy country for American Indians. Napoleon, faced by a long campaign, offered a 12,000-franc prize to anyone who would invent a way to keep food fresh on long marches; it was won by N. Appert, a Parisian confectioner, who packed it in air-tight jars - and thus gave the world canning. Gail Borden helped Lincoln's armies win the Civil War by condensing milk. Evaporated milk reached its fullest development in World War I.

World War II is giving us (1) dehydration, (2) improved freezing methods, and (3) new ways of packaging food. Already these three developments are revolutionizing your pantry, and, when the war is won, will alter food habits of people the world around. They are worth understanding. Look first at the simplest and most spectacular:

1. Dehydration. In principle, it is as simple as the sun, which has been dehydrating things -

driving the water out of them - ever since it dried earth's first grape. That's all dehydration means - dewatering. Most foods, we've long known, are from 10 to 90 percent water. Eggs, for instance, are 75 percent water; cheese, solid as it seems, is 30 percent.

So now in wartime, when we need to pack the most food in the least space, we scientifically deprive it of all but about 3 to 10 percent of its moisture, and thus shrink its bulk so greatly that one ship will haul as much of it as five or ten ships could in its natural form. And that one ship need not even be refrigerated.

Here, for example, is what dehydration does to the size of some foods you know: The juice of 25 cases of oranges, dehydrated, fills one small case. A case of 30 dozen eggs displacing two cubic feet shrinks to a case occupying less than half a cubic foot. An amount of milk, canned, which would require 121 ships to transport it, needs, when powdered, only 29 ships of the same size. (Incidentally, the first shipment of dried milk went to the gallant defenders of Malta. Today one-third of the milk shipped from America is in that form). Such fantastic reductions in bulk make the estimate that dehydration has spared 1,000 ships easily believable.

Weight savings are almost as impressive. Eighteen pounds of cabbage, 11 of milk, and four of meat become, dehydrated, one pound, respectively.

True, these "war babies," sired by lend-lease and born of tin and shipping shortages, are not so pretty to look at as fresh leafy vegetables or good red meat. Various they resemble such things as dog biscuits, brown sugar, popcorn, greenish-white shreds, or wood shavings. But drunked and cooked in water, they swell and come to life with virtually no loss in proteins, carbohydrates, and minerals;

no more loss in vitamins than occurs in fresh produce stored in a secure and even almost no sacrifice of flavor. So America is going to send abroad food and more food, not water, since water from the Nile or the Thames or the Danube can be got on the spot.

Here's how a 1943 overseas Army cook prepares whipped potatoes: He takes five gallons of pre-cooked, shredded, dehydrated potatoes, adds five gallons of boiling water, salts them, and cooks for five minutes over low heat. Then he whips at high speed for two minutes, adding butter and two gallons of milk. The whole procedure takes only a few minutes, and the product is indistinguishable from one made with natural "spuds". And - no "K.P." victims had to do the peeling!

But somewhere there's a veteran who's going to explain that they used to dish out these "dehydrated" foods in the last War, and in earlier years, and that they tasted like hell. For that matter, "desiccated" vegetables were used during the American Civil War. The soldiers called them "desecrated". Dried codfish dates even further back; it was the first colonial export. Go back further still and you find that Indians used to live on dried "jerky" beef and corn; still further, that Genghis Khan's soldiers were sustained by dried mares' milk. You yourself are familiar with dried plums (prunes), dried grapes (raisins), perhaps dried apples.

No, dried foods aren't new .... but between those of Grandma's day and the dehydrated product of today there's as much difference as that between his spring wagon and his grandson's F-17 bomber. Science has done it. The basic principle in all food-dehydrating processes is the drying of cut-up or ground foods from the inside out. If great heat is applied at the beginning, there is danger of the

formation of a waxlike structure on the surface of powdered or crystallized foods. Therefore, exteriors are kept moist by controlled humidity until the innermost part of the product has acquired the desired temperature. After this heat is increased, the product gives off its own moisture, and becomes dehydrated within seven to 15 hours.

In modern dehydration careful processing of the raw food before the actual drying operation helps to insure the quality and keeping stamina of the ultimate product. There are careful selection, washing, grinding, or slicing where necessary, and, with every vegetable but onions, blanching. Blanching done usually with steam, but occasionally with water, renders inactive certain chemical substances (enzymes) which would otherwise cause deterioration.

The commonest methods of dehydration are spray, tray, and revolving drums. Tomatoes, for example, are sprayed onto hot revolving drums. Their water content evaporates quickly, and they peel off the drums like paper. By one method, milk is sprayed in a fine mist into a drying chamber, where it strikes a current of warm air and falls in a split second as fine white powder; by another, it is run onto a hot drum and scraped off. Eggs are sometimes sprayed, sometimes dried in metal trays in cabinets through which hot air is forced. One dozen eggs thus shrink to a five-ounce, vest-pocket package of powder which is good in almost any recipe calling for eggs, and which also, on its own, can be successfully scrambled.

Let's follow six crates of carrots, weighing 198 pounds, from bulk to concentrate. The vegetables arrive at the dehydration plant about an hour old. They are topped, trimmed, washed, scraped, cut into quarter-inch disks, and spread evenly over wire trays. They are exposed to steam for six

...then go into the dehydrators at 150° to 200° F. for four hours. The result is a dry powder, which fills the fly-bottle area.

Even more, thanks to experiments by the Department of Agriculture and by meat makers, is being successfully dehydrated. So far the mixture of meat or fish is, of course, still a fine brown, but ground beef and pork emerge as delectable hamburgers or stews.

Butter oil that won't spoil, even at a temperature of 110°, is another dehydration achievement. Mixed with skim-milk powder, cold water, and salt, it becomes an excellent butter substitute, retaining its food values and saving 20 percent shipping space.

But perhaps the newest development in this new industry is compression. It's a matter of minding the lily! First, by dehydration, you drive out the water, then, by squeezing, you expel the air as well. Foods so treated are compressed into blocks or briquettes, with a 30 percent reduction in bulk and an 80 percent reduction in room-of-canned soup. One pound of brick potatoes yields 24 servings; a shoe-boxful, 100. Dinner in a capsule isn't yet with us, but your soldier com's "H" or "parachute" rations come close. They consist of three good meals in three compact little packages usable from 20° below zero to 135° above.

A few dehydrated products have reached your table: packaged soups, onion and celery salt, eggs and milk in commercial bread, cakes and ice cream. All the war which made this industry also made it all but out. About 200 American companies are dehydrating today as against five in 1940, and nearly all their products are exported. The post-war uses of dehydrated products are nevertheless numerous. They may make a major breakthrough during the period, variously estimated at from 18 months to

six years, when the United States must be the world's pantry. They will serve as a reserve, easily transportable, in times of flood or other disasters. They can, as a cheap, wholesome, and easily moved food, do much to insure the fourth freedom - freedom from want. They will make life more pleasant for the housewife.

2. Improved freezing methods. Quick freezing applied science's antispoilage triumph, like dehydration, has a past and a future. Frozen fish were nothing new when, in 1931, frozen food in packages was put on the market for the first time.

All modern quick-freezing techniques have speed in common. In slow freezing, large ice crystals form, which break cell walls, cause juices to run out under thawing, and tend to destroy food value. In fast freezing, crystals are small and harmless. In addition, quick-frozen foods don't dry out or oxidize.

Here is how peas are processed by the Birdseye method: Within half an hour they go from vining machine which shells them to freezing plant, where they are graded, washed, and blanched in a brief steam bath. After inspection they are packed in wax board boxes lined with cellophane and placed on deep metal shelves in an insulated cabinet. Then the shelves accordion up until the packages are so tightly sandwiched that air is driven from the cabinet. A refrigerant circulates, freezing the peas in about one and one-half hours.

Freezing time varies with products and methods. The Murphy technique freezes the food on trays on refrigerated shelves. Some foods, like poultry, don't lend themselves well to uniform packaging. An ingenious way of freezing chickens is to thrust paraffin tubes carrying a freezing solution through the birds for 30 to 35 minutes.

No more than dehydrated foods resemble the  
canned, dried fruits. Quick-frozen fruits have the appearance and taste  
associated with "faded storage". Actually they're  
fresher than fresh. Harvested from field to freezing  
plant, they retain a quality rare in the "fresh"  
vegetative foods in our markets.

Though the war didn't give birth to quick freezing,  
it has stimulated its growth. To prevent spoil-  
ages under labour shortages in canneries, certain  
fruits are quick frozen and kept under refrigeration  
until they can be canned. Exposure to live steam  
quickly defrosts and peels them. Locker storage  
plants, a development of the past few years, are  
now more useful than ever. Like safe deposit boxes  
lockers are rented to farmers, who can freeze and  
preserve products for their own consumption. Army  
posts all over the United States store frozen foods  
in huge quantities.

Frozen food eliminates "out of season", and  
makes possible the distribution of fresh food the  
year round at year-round prices. In addition, it  
reduces transportation burdens. In packaged foods,  
waste - 70% in cauliflower, 80% in red-orch fillets,  
25% in swordfish, for example - is eliminated before  
packaging. Perhaps the day is not far off when the  
housewife will consider it as antiquated to shell  
her own vegetables as she now considers it to bake  
her own bread.

3. New packaging Methods. Another method of  
preserving food, canning, had reached virtual per-  
fection long before the war. But with 90 percent of  
America's normal tin supply cut off, canners worked  
out new kinds of containers.

Glass has been so successful an emergency container that many products will continue to find a home in it. The only reasons that use of glass has been slowed down are that machinery necessary for processing in glass instead of in tin cans is hard to get, and that glass requires rubber closures.

Cans, those old stand-bys, have learned new tricks. Tin cans aren't really tin; they're steel, coated with tin that prevents food from touching the steel and becoming contaminated. The old "hot dip" method of manufacturing tin cans requires one and one-half pounds of tin to approximately every 100 lbs. of steel. A new method of coating the steel with tin by electrolysis, similar to the method used for nickel or chromium plating, reduces the amount of tin needed by two-thirds. For low-acid products, tin can now be entirely eliminated through the use of Bonderized steel. Bonderizing is a process whereby "black sheet" - the steelmakers' term for uncoated, but still shiny, steel sheet - is made rust and corrosion resistant with an ~~xx~~ iron-phosphate coating. Bonderized steel takes lacquer or enamel, which is applied to the inside of the can.

Some substitutes now used in canning are so successful that laboratory people refer to them as "alternates". Indium, a little used metal, is helping to fill the tin breach. Silver, in thickness of  $1/100$  of an inch, serves as plating, also as a component of solder. Cellophanelined fiber containers are germproof, insectproof, and heat resistant. Paper, covered with paraffin, chemically treated or laminated, safely surrounds many kinds of foods. Waterproof sealed fiber containers withstand insects and extreme temperature, air, and water conditions.

Other war adaptations that may change our menus relate to new uses of old products. Peanuts and soybeans give us the oils that used to be olive.

Gelatin now has a role as a butter extender. There's a bean in "coffee" frankly made of cereal. Soybeans are just beginning to come into their own as food; they can be baked, boiled, and eaten like any other beans. Soybean flour stretches the precious meat in sausages. It's anybody's guess how many of these "alternates" will survive on dining-room tables after the war.

Meanwhile, each war-modified container is a triumph of ingenuity; each quick-frozen pound of fish, meat, vegetables, or fruits is keeping food fresh for the lean season or the faraway place; and, above all, as Secretary of Agriculture Claude R. Wickard says, "Every ton of water drawn out of milk, meat, eggs, fruits, or vegetables is like a ton of bombs dropped on the Axis".

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## THANKS FOR ENRICHED BREAD

(Submitted by Jane Stafford for November 10, 1947)

JANE STAFFORD

"Staff of life" of colonial times was rich in nourishment provided by whole wheat berry; modern bread is artificially supplied with vitamins.

Grace before Thanksgiving Day dinners this year might well include a line of thanks for enriched bread. Because in spite of how the war has hit the American dinner table, our daily bread is better than ever before and better, probably, than that eaten by any other people the world over.

Efforts to give us the better bread started long before the war, but reached full momentum under the pressure of war and its effects on the national diet. Now that the war is forcing us to depend more and more on cereals, we can be doubly grateful for our enriched bread which gives this sturdier staff of life.

The bread on early American Thanksgiving dinner tables was made from stone-ground flour. This flour had in it most of the rich nourishment of the wheat berry; the protein and minerals and vitamins as well the starch. It was however rather coarse and far from the snowy white flour we are accustomed to use today. The refinement of flour by modern milling processes gives a product that makes delectable bread, cakes and other baked goods, but it robs them of much of the wheat berry's nourishment rather than its starch.

This did not matter so much, perhaps, so long as people could get plenty of fresh meat and fresh vegetables to supply the protein, minerals and vitamins their bodies needed. Even before the war and rationing however fresh meat and fresh vegetables were rather scarce items on the dinner tables of a large part of the population. According to some estimates, two-thirds of the people could not afford enough of these foods to keep themselves healthy and strong.

For the most part, these people were not actually sick in bed. They just dragged along, feeling tired and peopless, often too weak to do a good job when they had work, suffering from vague aches and ailments and getting upset too easily by trifles. Quite a number of them did get sick. They got a skin rash, sore tongue, digestive trouble. They couldn't eat any thing and some went crazy. Some died. These were the ones with pellagra, the disease that comes from the lack of a B vitamin called "niacin".

After the role of niacin in preventing and curing pellagra was discovered, doctors could fill these very sick people full of niacin and, as their appetite and digestion improved, could feed them the niacin-rich foods their bodies were starving for. But every spring the people would be sick again because during the winter they could not afford the higher priced, nourishing, fresh meat and vegetables. Even their pet dogs got sick.

Other people got neuritis. A few actually had beriberi, the disease generally considered Oriental only, because it was so prevalent in oriental countries where the native diet consisted largely of vitamin-l polished rice. The beriberi and neuritis result from a diet lacking another B vitamin, thiamin.

Doctors used to examine many other B vitamins. Doctors for years have seen signs of a dietary lack of some of these other B vitamins also in their patients. In fact, about the time of the depression, doctors seeing so many patients very sick, half sick and just a little sick from lack of vitamins became seriously worried about the situation. So did nutritionists and various governmental authorities.

It became increasingly clear that something would have to be done to get the vitamins into the food these people could afford and leaned on heavily for the bulk of their diet. Chemists had found a way to make the three main B vitamins - thiamin, niacin and riboflavin - in the laboratory. Drug manufacturing houses were making them and putting them up in vitamin pills.

These pills are all very well if you can afford them. If you can however the chances are you can also afford fresh meat and vegetables and do not depend largely on bread for your daily food. If you are at the economic level of a bread-potato-fat back diet, even a few cents a day is more than you can afford for vitamin pills, month in and month out.

So the doctors and nutritionists and government authorities, the millers and bakers, too, decided it would be best for all concerned to enrich our fine white bread by adding to it thiamin, niacin, riboflavin and iron. The first step consisted in setting up legal standards, based on scientific knowledge, for how much of these ingredients must be in a loaf of bread that may be labelled enriched. Many bakers then produced enriched bread which they sold at no extra cost to the consumer.

For a time, the matter of making or eating enriched bread was optional. Then came the war, and the realization that all of us, rich or poor, would

have to eat more bread and cereals as other foods be relatively scarce. England and Canada had already ad a national loaf of bread to add needed nourishment t time diets in those countries.

In January of this year, Food Distribution Ord No.1 was iss ued in the United States. This required among other things that all bakery white pan bread sold in this country must be enriched bread. Bread baked at home , or in restaurants or institutions, could be enriched or not, but that sold at bakery, grocery stores and the like, must be enriched.

Unfortunately, it has also been necessary beca of the war to reduce the amount of milk that most ba used to put into bread. Leaving out the milk leaves some important calcium and protein. If our present enriched bread could be made, as bread was formerly made, with 6 per cent dried milk solids, it would be so nourishing that a loaf of bread and a tomato woul all a grown person would need for a day's food.

Even without the milk, the daily bread most of eat is now a very nourishing product, one we can be thankful to have on our table for Thanksgiving dinner

All of us may be eating this kind of bread bef long, whether we buy bakery bread or bake it at home. Our rolls, pies, biscuits, buns, doughnuts and other bakery foods will also be enriched, if plans now und discussion can be carried out.

These plans call for enrichment not of bread a but of all white flour. At present some flour is enr and some is not. Bakery bread is enriched by being m from enriched flour, or by being made with a special yeast that adds extra vitamins, or by being made fro ordinary flour with a vitamin and mineral concentrat added to it.

Extending the benefits of bread enrichment to all people in the nation, regardless of where their bread is baked and of whether or not they eat rolls

biscuits or buns instead of bread, is the aim of those who argue for enrichment of the mill, not at the bakery.

The nutritional fault, it is pointed out, is with the flour, not the bread, so it would be more logical and effective to enrich the flour itself from which the bread and many other foods are made. At a public hearing last summer, bakers opposed the plan for enriching all white flour and no governmental order has yet been issued.

Housewives who bake their own bread and rolls, however, can get enriched flour if they wish. It has been on the market for about two years, although in some parts of the country grocers may not be handling it.

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## MORE ENRICHMENT

By  
Jane Stafford.

Sturdier staff of life as a support through possible scarcities, and pastries, cakes and crackers added to enriched list are possibilities for next winter.

By Thanksgiving, or soon after, Americans may be laying a new cause for thanks in the food line. In spite of rationing and war-caused food shortages, if the latest proposal of the War Food Administration goes into effect promptly.

The proposal is to require all white flour sold for human consumption to be enriched with certain vitamins and iron according to the latest federal definition of enriched flour. The proposed order's 30-day allowance for millers and bakers to make the changeover would be just about up by Thanksgiving if the order were issued shortly after announcement of the proposal.

The stuffing of the Thanksgiving turkey or his substitute in that case may be more than just stuffing. The crust of the mince meat or pumpkin pie would be in the "good for you" class. And bread, traditionally the staff of life, would be a sturdier staff than it has been in a long time.

Equally important, everyone of us in the United States, if the order goes into effect, will be getting this mineral and vitamin enriched bread, whether we buy bread from the grocer or baker, eat it in restaurants, or bake it at home.

Balls, pies and other pastries, cakes, biscuits and crackers will, if the proposed order goes through

without change, be made from enriched flour, making the more nourishing than before. Up to the present, these as well as home and restaurant baked bread and rolls, or may not have been made of enriched flour. Food Distribution Order No. 1, issued last January, required all white pan bread to be enriched, but other flour products including home-baked, were not covered by the order.

### PROTECTION FROM DISEASE

The object of the proposed new order for enrichment of all white flour with certain B vitamins and iron is to protect civilians on wartime diets from vitamin lack diseases, such as pellagra and beriberi, and even from such mild states of undernourishment as make them feel tired and cranky and keep them from doing their best work. Our soldiers are already protected by an order under which the Army buys only enriched flour, although Army rations are planned to include plenty of other vitamin rich foods. Civilian diet will depend much more on bread and flour as the war continues.

Our new enriched flour may be coming as a war measure but it will not be a dark flour, nor will bread made from it be a dark, wartime bread such as the English national loaf of 85% extraction wheat flour. It will make bread which will carry even more nourishment than the English national loaf, or than has been in the enriched flour sold in some communities during the past two years.

Announcement of the new enrichment proposal comes on the heels of two significant acts which probably few American bread eaters know about. One of these is a new Food Drug and Cosmetic Administration order increasing the minimum amounts of certain vitamins and iron required in enriched flour. The other is a U.S. Supreme Court decision upholding the Food, Drug and Cosmetic Administration whose regulations on enriched flour and farina had been challenged.

## WITHIN LEGAL RIGHTS

The Supreme Court found that this federal agency is quite within its legal rights in setting standards for the number, names and proportions of ingredients which may be added to food sold under a common or usual name, such as enriched flour. If there were no standards of identity for enriched flour, for example, the consumer would have to rely on the label on each package to learn which vitamins and minerals and how much of each package had been added to a certain company's enriched flour and how much nutritional benefit he might get from eating that flour in his bread.

That requires more technical knowledge, the decision points out, than the average consumer is likely to have. As a result, he might be misled into thinking he would get more benefit from the product than would actually be the case. It was to avoid such a state of confusion that Congress empowered the Federal Security Administrator, under one of the provisions of the Food, Drug and Cosmetic Act, to set standards of identity for food when he considered this action necessary to promote honesty and fair dealing in the interest of consumers.

With this green light from the Supreme Court, Food, Drug and Cosmetic Administration has issued the new standards for enriched flour which will go into effect about October 1. After that date, any flour sold as enriched will be richer by at least a third in the morale vitamin B<sub>1</sub>, or thiamin, than enriched flour had to be in the past. It will contain more than two and one-half times as much of the pellagra-preventing vitamin, niacin, and more than twice as much iron as the previous minimum standards called for. In addition, it will contain another B vitamin, riboflavin.

RECENTLY MADE AVAILABLE

Original plans for flour and bread enrichment called for this vitamin but only recently has enough of the synthetic riboflavin been made available to make it possible to add it to flour or bread. Calcium, bonebuilding ingredient found abundantly in milk, remains an optional ingredient within certain new limits of some enriched flours but becomes a must ingredient in enriched self-rising flours,

The reason for increasing the amounts of vitamin and iron in enriched flour is that scientists have made further studies of the nourishing factors in the diets of various income groups and the population as a whole and of the daily allowances of various vitamins and minerals required for health. As a result, they found that the original standards for enriched flour would not give people eating it the degree of nutritional improvement expected on the basis of findings before the enrichment standards were set. Nor would it give the improvement consumers are entitled to expect from the publicity regarding enriched flour and bread made from it.

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A Reprint from  
Science News Letter, August 7, 1943.

## BREAD PREVENTS DISEASE

Two vitamin hunger diseases, beriberi and pellagra, have decreased "markedly and unmistakably" in New York as a result of bread enrichment.

Bread is now preventing disease. Cases of two vitamin hunger diseases, beriberi and pellagra, have decreased "markedly and unmistakably" in the wards of Bellevue Hospital, New York, during 1942 and 1943, a period when enriched white bread and flour became universally available in that city. Dr. Norman Jolliffe, New York University College of Medicine, declared at the meeting called by the Food Distribution Administrator to consider compulsory enrichment of all white flour as a war measure.

Only one-fourth as many patients with full-blown beriberi and only one-third as many pellagra patients were seen now in the wards of this hospital as were there in 1939, Dr. Jolliffe stated. He attributes this decrease to the bread enrichment program through which people are getting much more of the pellagra-preventing vitamins, niacin and thiamin, than formerly.

Opposition, strongly vocal and somewhat unexpected to the proposal for enriching all white flour developed from representatives of the baking industry, who urged enriching bread and other flour products at the bakery, rather than at the mill. Increased costs to bakers; loss of prestige and hurt pride because the bakers have heretofore played a big part in pushing the enrichment program; and fear of possible loss or waste of vitamins either in stored flour or in manufacture of certain bakery goods were the chief reasons given.

Evidence that destruction of vitamins in flour during storage would not be serious, nor the loss in

baking crackers and such items very large, was proposed by those favouring enrichment at the mill.

Government authorities lean to enrichment at the mill because of greater ease of enforcement of the order. The large number of bakeries, many of them small, would make supervision of enrichment of bread and bakery goods extremely difficult.

Millers seem willing to take on the entirement job. They are already enriching a large proportion of all flour and it is believed very few mills will buy any extra equipment to enrich all white flour.

Flour should be enriched at the mill, Dr. Russ Wilder, chief of civilian food requirements branch of the Food Distribution Administration, declared, because the fault has been with the flour, not the bread. Finely milled white flour loses important vitamins and iron in the milling process. Enriching flour at the mill or source, he pointed out, follows the logic of purifying the water supply of an entire city rather than doing the job in each home and public building.

Whether all or only part of white flour is to be enriched, it may be possible to distinguish it after October 1 by a very faint creamy tinge due to the vitamin riboflavin, which will be a must ingredient in all enriched flour and bread after that date. Riboflavin has a clear yellow colour. In flour and bread, however, the colour will be so diluted that most consumers probably will not notice it.

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Extracted from  
Science News Letter, August 7, 1943.

## ELECTRONS TO DEHYDRATE

The moisture content is reduced to only one per cent by use of radio-frequency energy in a new process of food dehydration.

Better food dehydration through use of radio-frequency energy to drive out the moisture has been developed. The process makes possible for the first time removal of 99% of the moisture content from a compressed vegetable block, reports Vernon W. Sherman of Federal Telephone and Radio Corporation, who developed the method in cooperation with the Office of the Quartermaster General of the Army.

Evidence indicates that vegetables dehydrated by the electronic method will not deteriorate over a period of one to two years even in hot, humid climates.

As a first step, 80% of the water content of vegetables is removed by conventional dehydration. The vegetables are compressed into blocks from which the remaining moisture is reduced to one per cent by radio-frequency energy in appartial vacuum. Since other methods of drying require the exposure of as much of the vegetable surface as possible, this process of compressing the vegetables into tight blocks, prior to drying them further, is unprecedented. It is done to concentrate a large amount of food in a small magnetic field for reasons of economy.

About five per cent moisture is generally left in the food by ordinary dehydration using hot air, which involves danger of spoilage, especially in the tropics. Attempts to reduce this moisture content by warm air often give the dried vegetables a tough, blackened skin, called "case hardening", but this does occur when radio-frequency energy of the proper wave

length is used. Drying is accomplished in about an hour. The shortwave energy is actually turned on only a part of this time. Due to the speed of the process, apparently, the vitamin content of the dried foods is reported to be unusually high.

The temperature throughout the foods being dried is said to be remarkably uniform, unlike the difference between the outside and inside of food under dehydration by other methods. Electronic drying is well adapted to automatic straight line production, and from laboratory results engineers calculate that one pound of water may be removed electronically as described with less than one kilowatt hour of energy, costing about one cent, which compares favourably with the cost of other methods.

Plans are being considered for construction of a 50-kilowatt electronic food-drier, which would handle six tons a day of dried food, equivalent to perhaps sixty tons of fresh food, to test the new food dehydration method on a commercial scale.

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Extracted from  
Science News Letter, August 28, 1943.

"T I M E"  
26th April, 1943

Vitamin Bandwagon:

From the meeting of the National Wholesale Druggists Association in Chicago last week came an astonishing fact: at least a fourth of all retail drug sales are synthetic vitamins or vitamin concentrates. They are now the largest single class of products handled by wholesalers.

The rush to buy vitamins does not stop there. There is also a large trade outside the drugstores. Many industries with hundreds of thousands of employees do not trust to home cooking to keep their workers healthy and alert. Fearing vitamin deficiencies, they also provide protection from disease and fatigue in vitamin pills, capsules or biscuits to be taken daily.

Even larger quantities of vitamins are used in food processing for the enrichment of bread, margarine, milk etc.

Four of the ten best-known vitamins are now manufactured in chemical works on a tonnage basis. The total annual production of synthetics and concentrates exceeds \$100 million. Yet no synthetic vitamin was marketed before 1937.

The original list of four vitamins (A, B, C, D) has been extended to 13. Vitamin B, a complex, has been separated into at least eight distinct chemicals. In addition, vitamins E and K are more recent discoveries. Half a dozen others are suspected and may soon be recognised. With such complexity, the alphabetical system of names has broken down and the chemical names have come into general use,\*

Except for vitamins A and D which are not manufactured chemically, are sold only as concentrates from fish-liver oils.

## The Synthetics:

Eight of the vitamins are now produced by the chemical industry in pure form, identical with the plant or animal product:

Ascorbic acid (formerly vitamin C), contained in tomatoes and citrus fruits, is a simple chemical made from glucose. In 1934 its price was \$213 an ounce; in it became the first of the vitamins to be manufactured synthetically and its price dropped to \$3.60 an ounce. Today it is made on a scale of about 100 tons a year at \$1 an ounce. One ounce is enough for the daily need of about 500 adults.

Thiamin (formerly vitamin B<sub>1</sub>), preventive of beriberi, neuritis and loss of appetites, was formerly extracted from rice-polishings, once cost \$300 a gram. It now costs 37 ¢ a gram. Made by the ton, it goes chiefly into enriched white flour, to restore what is lost from the whole wheat in milling.

Riboflavin (formerly vitamin B<sub>2</sub>) is widely used in the poultry industry to stimulate egg production is also used as a preventive of some eye inflammations and fissures of the lips. It is recommended for the enrichment of bread, but the supply is small because of the shortage of equipment in wartime. Within the past year its price has dropped from 75 ¢ to 58 ¢ a gram.

Niacin (formerly nicotinic acid) is the chief constituent of the B-complex and prevents pellagra. It is now the cheapest of the synthetics - \$5 a pound.

Pyridoxin and pantothenic acid are the remaining known constituents of the former B-complex. They are newly developed, often omitted from multiple-vitamin preparations. Pantothenic acid is popular as a possible preventive of grey hair.

Tocopherol (vitamin E) and methyl naphthoquinone (equivalent of Vitamin K) complete the list of the vitamins that are available from chemical manufacture. They are still little used. The former is essential for reproduction in rats, so that it has become known as the sex vitamin but doctors are still uncertain whether it has any such value in human beings. The latter is unique; it is not vitamin K, but is equally effective in decreasing the clotting time of blood.

### The Unknowns:

At least five other vitamins have been identified chemically\*, but no one knows how many more there may be, or what they do. For the vitamins not yet identified, concentrates are made from a list of weird items reminiscent of a Chinese pharmacopoeia: yeast, wheat germ, defatted milk, rice polishings, grass juice and liver extract.

One thing about vitamins is definite. They are no substitute for food; they provide no energies, calories, or body-building materials, are merely accessory to diet. But in many ways they are still mysterious - hence doctors still urge the necessity for balanced diets and warn against dependence on pills.

The drugstore pill-eater can ensure health by taking the entire list, but if he is to buy wisely he has much to learn of both chemistry and medicine. As with the patent medicines of a former day, the greatest harm is the waste of money.

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\* The five: biotin, choline, inositol, para-aminobenzoic acid, folic acid.

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## EMERGENCY FOOD RATIONS

### GO INTO USE.

During the last three years scientists at the Massachusetts Institute of Technology have been trying to determine how to pack the utmost of nutritional value into the minimum of food bulk and at the least cost.

Through numerous experiments, first with animal and then with human volunteers, they developed formulae which concentrate into a  $1\frac{1}{2}$  pound package of food all the daily requirements for one individual in proteins, calories, vitamins, and minerals. With this concentrate as a base, the nutritional biochemists have been able to work out special food problems for several government agencies, including the Army, the Navy, the Merchant Marine, and the Federal Surplus Commodities Corporation. Among the problems studied are rations for submarine crews, lifeboat rations, and emergency rations for pilots and soldiers detached from the home base. Packaged food concentrates to be dropped from aircraft have been developed. Both Russian and British representatives tested the concentrated food, and certain shipments of it have been made to their home lands.

This nutritional research at M.I.T., which is in charge of Dr. Robert S. Harris, had its origin in 1938 when Admiral Byrd was preparing for his most recent voyage to the Antarctic. On previous expeditions Byrd had had difficulty with the trail rations or pemmican which constituted a large part of his food supply. This beef mixture was unpalatable and not nutritious, and to guard against such mishaps on his next voyage the explorer appointed Dr. Harris nutritional adviser. The biochemist enlisted several of his students as associates, and together they worked out a compact mixture of dried meat, cereals milk powder, yeast, dried vegetables, and seasoning

hydrated man that stood up wonderfully under severe test of the Antarctic winter and won it from Byrd.

In 1940 Harris and his group began to consider question of nutrition, not from the point of view of an isolated polar expedition, but rather that of the general public. The press was flooded with dietary advice at this time. There were reports of government surveys showing the low nutritional value of the prevalent diets, and the importance of meat, eggs, fresh fruits, vegetables, and milk was widely stressed.

"But the official food surveys showed that in order to obtain the recommended quantities of meat, eggs, fruits, vegetables, and milk, an expenditure of from \$2.50 to \$9 per person per week was necessary", said Dr. Harris, "and the income statistics showed that such outlays for food were beyond the resources of a majority of the families having three or more members. It was to meet this problem, to assure adequate nourishment with the most critical dietary essentials at very low cost, that we began our experiments with food mixtures in 1940".

The basic formula was arrived at through tests on rats. After it had been demonstrated in animals that the low-cost concentrate provided the necessary vitamins and minerals, the men in the laboratory began to try it on themselves. For six weeks Harris and his associates lived on their mixture which cost only six cents a day. They did not grow fat, but did stay in perfect health.

Later, a group of 12 business men in Boston agreed to live on the same diet, which was provided in a form similar to cereal flakes. They stuck out for five weeks, indeed developed a liking for the concentrate, and demonstrated that dietary monotony can be outgrown.

Meanwhile, the N.I.T. biochemists had developed another type of food concentrate. This packed all the daily requirements of critical foods - the vitamins and minerals - plus one-sixth of the protein requirements and one-twentieth of the calorie requirements, into one ounce of soup powder. And last year this concentrate was tried on 760 school children in five small communities of Michigan, in a study financed by The Kellogg Foundation.

Each of the five schools had been providing its pupils with lunch for several years, and the point of the experiment was to enrich these lunches by adding to the daily fare a cup of soup made from the one-ounce soup concentrate. Since the test was preceded in each case by a thorough medical examination of the child, including inspection of eyes, nose, throat, skin, mucous membrane, skeleton and neuro-muscular reactions, it was possible at the end of the three months to check up on the results of this lunch enrichment demonstration. Moreover, an equal percentage of the pupils in each school served as a control group, received the regular lunch without the soup, and provided a basis for comparison. The results of these comparisons were striking. A marked improvement over various deficiency conditions had taken place.

Another fact which this study disclosed was the failure of the ordinary hot school lunch to provide an adequate complement to the home feeding of the child. There was evidence in the majority of the children that the home foods were providing calories and protein, but were sadly wanting in vitamins and minerals. The soup concentrate was planned to supply these, and added to the conventional home diet it should correct the ordinary deficiency diseases and safeguard against their recurrence.

The ingredients? Mainly they are skim milk powder, peanut flour, soya flour, and powdered peas,

with added pepper, salt, vitamins, and minerals. Each ounce of the powder dissolves in a cup of hot water to produce a soup portion containing these nutrients:

Vitamin A	4500 international units
Vitamin B <sub>1</sub> (thiamine)	1.2 milligrams
Vitamin B <sub>2</sub> (riboflavin)	1.6 milligrams
Niacin	12.0 milligrams
Vitamin C	75.0 milligrams
Vitamin D	400 international units
Iron	12 milligrams
Calcium	1.2 grams
Protein	12 grams

In later experiments it was found that the protein content and palatability could be improved by substituting the powder of corn germ for peanut flour. Corn germ has a protein closely approximating that of meat, and it is being used in current production of the concentrate. Several manufacturing concerns, on contracts with U.S. Government agencies, are producing this type of soup powder. Ration biscuits made according to other formulae are also being produced. Production costs, says Dr. Harris, average 2.3 cents per serving, packaged and ready for shipment, "whereas equivalent nutrition in natural foods would cost in excess of 25 cents, and even this would not be fully reliable in nutritional content".

A grant from the Eastman Kodak Company is financing a new study which Dr. Harris is at present conducting for the Committee on Nutrition in Industry of the National Research Council. Here the problem is to see what effect, if any, vitamin and mineral enrichment of diet may have on the health, working efficiency, and output of industrial workers. Six hundred employees of the Eastman Kodak Company at Rochester, N.Y., have volunteered as subjects for this study. A complete

physical and medical check-up of their condition is made at the beginning, and another will be made at the end of the experiment, using the most recent methods of nutritional appraisal. Records will be kept of such details as the incidence of colds and other ailments, tardiness, absenteeism, attention to work, production rate, and other factors reflecting efficiency, from which comparisons may be drawn.

Still another step in the development of the program has just been taken, carrying the work into an international phase. The N.I.T. laboratories have entered into an arrangement to make a nutritional survey in Mexico, similar to the study of school children in Michigan. This work will be done in collaboration with Mexican government agencies and the Pan American Sanitary Bureau, with additional financial aid from the Kellogg Foundation.

The research program is continuing at Cambridge, with the support of The Rockefeller Foundation grant. This project is within the Department of Biological Engineering, and is a concrete example of biological engineering at work.

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UNITED STATES OFFICE OF WAR INFORMATION

"Medical letter For Doctors Druggists Scientists"  
Extract from "Med. J. No. 7"  
7th August 1943.

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What U.S doctors are talking about:

The Smithsonian Institution in Washington adapting its research to the war effort. Since the United States was thrust into the war, over 500 scientific problems have been presented to the Institution, many solved. A special committee has been appointed for coordinating the scientific war efforts of the staff of nearly 100 scientists..... The latest addition to large scale, low cost, high nourishment feeding; a three-cent soup mix made of skim milk powder, peanut flour, soya flour and peas, inherently rich in good protein and in vitamins of the B complex. Each ounce will supply a full day's allowance of these diet essentials. 426 children consumed it daily for 3 months, didn't tire of it, and showed an improvement in health... The production in crystal form of four new "superpotent" forms of vitamin A, isolated from fish livers, the three other crystalline esters of vitamin A, that is pure vitamin A, combined with fatty acids, forming vitamin A acetate, palmitate and succinate. Vitamin A acetate offers greater resistance to deterioration on exposure to air than any other vitamin A crystalline material so far known. One gram of the new mineral has the potency of at least 4,300,000 United States pharmaceutical units.

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JOURNAL OF SCIENTIFIC AND INDUSTRIAL  
RESEARCH. VOL. II. NO. I

October, 1943.

SHARK LIVER OIL INDUSTRY IN INDIA:

The growth of the shark liver oil industry in India during the past 3 years, is as much due to the pioneering efforts of the fisheries departments of Travancore and Cochin, as to the valuable researches carried out at the Nutrition Research Institute, Cochin. A stage has been reached when the manufacture and marketing of the liver oil has to be organised on a strictly scientific basis. A review of the present position of the industry has appeared in a recent number of Current Science (1943, 12, 825).

It has been pointed out that the method employed for the collection of the livers and the extraction of the oil therefrom are far from satisfactory. There is no specified shark fishing season, and in view of the uncertainty and the scattered nature of the collections, the extraction of the oil in many coastal regions has become a cottage industry with the result that a large quantity of the oil found in the market, is produced by indigenous methods and extensive and unscrupulous adulteration is practised.

A scientific study of the shark liver oil industry in India is a pressing necessity. Methods have to be developed for preventing rancidity in the oil during storage and for the quantitative separation of sterine. Recent developments in vitamin technology, e.g. preparation of concentrates by molecular distillation, have to be taken advantage of, and systematic studies on the seasonal variation in the vitamin content of fish livers and on the treatment and extraction of the oil from them, have to be carried out for the permanency of the industry in India.

THE ROLE OF VITAMIN CONCENTRATES IN WAR AND IN  
POST-WAR FOOD RELIEF IN EUROPE

By

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NUTRITION ABSTRACTS AND REVIEWS  
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# THE ROLE OF VITAMIN CONCENTRATES IN WAR AND IN POST-WAR FOOD ALLIES IN EUROPE.

## INTRODUCTION

It is axiomatic that vitamin concentrates and synthetic vitamins should not be used when natural sources are available in adequate amounts. However desirable in theory it may be to adhere to a precept, practical considerations may demand deviation from it. Even during peace no nation has been able so to adjust its social and economic structures, general level of education and balance between food production and consumption as to secure fully good nutrition for more than a considerable portion of its population. We have so far accepted these conditions that it is taken as a matter of course that infants should be given supplements of vitamins and that margarine should be made nutritionally equal with butter by the addition of vitamin concentrates.

Aside from basic economic causes for the widespread use of poor diets the changing food habits of a considerable portion of the world's population have been deleterious. The universal use of white, "short extraction" flour and the great increase in the consumption of sugar by the English speaking peoples during the past sixty years have created a threat to the common health appreciated only recently by the nations concerned. Even in the emergency of war was required to bring about a change. In Britain where the situation was aggravated by large consumption of potatoes, the reduction of national wheatmeal probably has removed the danger of deficiency of the B group vitamins. Canada has adopted a high extraction flour of equally good nutritive value and the United States are experimenting with white flour of medium extraction enriched with synthetic vitamins.

With the medical profession committed in peace time to the use of vitamins and concentrates in paediatric and antenatal practice, and a nation at war adding vitamins to its flour, the question of attempting to improve the nutrition of the entire population by the use of various vitamin concentrates frequently has been raised. It is not possible to answer such a question categorically because the population cannot be considered as a unit, and in any case common sense demands that the need for supplementing any diet be demonstrated. Without doubt, for a nation at war an adequate diet is a prime essential to victory. Orr and Lubbock (1940) have discussed ways for providing a satisfactory diet for Britain with a minimum of imported food and have concluded that it is possible of accomplishment. They have even itemised an "emergency diet" capable of keeping the population in good health over long periods of time with a minimum of animal protein and of fats. Lyall (1942) has shown that the foods readily available in Britain at the present time can provide a diet adequate in all respects. The authors of both these dietary plans presuppose ability to purchase available foodstuffs and intelligent preparation of them for food.

In war it is not sufficient for the average diet to be just adequate. Certain groups of the population require special consideration. The nutrition of the personnel of the armed forces and of workers must at any cost be maintained at optimum levels. Even more important are young children and pregnant women, who are more susceptible to temporary deprivation. There seems to be no doubt of the excellence of the service rations though it is inevitable that methods of preparation should vary in their efficiency, and the prescribed emergency rations are adequate for the relatively short period during which they are planned to be used. Under certain conditions of warfare it is

unavoidable that small numbers of men shall suffer from temporary malnutrition and for this there is no practicable method of preparation except the previous steady intake of a good diet.

### EFFECT OF ENHANCING THE NORMAL VITAMIN SUPPLY

It has been suggested that an abundance of vitamins or an excess above the amounts considered optimal in normal nutrition may produce unusual stamina, or at least enable men to endure excessive and prolonged effort. Deschwenden (1940) and Morell (1940) seemed to imply this in their reports of tests carried out in the Swiss and German armies. Men were given unstated amounts of a dietary supplement rich in calories and vitamins; in Morell's experiment the material contained 62 percent of dextrose. It is not, however, evident that the improved performance reported was more than would be accounted for by the readily available calories of the supplement.

The only controlled observations made are those of Keys and Henschel (1941), in which 26 United States soldiers ate standard garrison rations while doing measured amounts of work on a treadmill. In four series of studies daily supplements of 5 to 17 mg. thiamine (vitamin B<sub>1</sub>), 100 mg. nicotinic acid, 10 mg. riboflavin, 20 mg. calcium pantothenate, 10 to 100 mg. pyridoxine (vitamin B<sub>6</sub>), and 100 to 200 mg. ascorbic acid were administered over periods of 4 to 6 weeks, alternating with placebos. The men expended from 3700 to 4200 Calories daily. The ration had a maximum caloric value of 4500 and, as eaten, an average content of 1.7 mg. vitamin B<sub>1</sub>, 2.4 mg. riboflavin and 70 mg. ascorbic acid daily. Due precautions were taken to eliminate the effects of training. The circulatory, metabolic and blood chemical responses were measured and subjective and objective reactions

noted. In neither extreme brief, nor prolonged severe exercise was there evidence of any effects, good or bad, on muscular ability, endurance, resistance to fatigue or recovery. Similar experiments done during "semi-starvation" gave similar results. The only men reporting subjective stimulation did so while taking placebos.

It has been suggested that the dark adaptation, and by inference the night vision, of aviators, look-outs and scouts might be improved by the ingestion of large amounts of vitamin A. No reliable information on the application of this suggestion is available but from what is known of the utilisation of vitamin A it is extremely unlikely that improvement in dark adaptation could be produced in a person not actually in a deficient state. Were it necessary for men to subsist for a considerable time on a diet poor in sources of vitamin A or carotene then, certainly, the administration of the vitamin would be indicated.

### VITAMIN SUPPLIES OF INDUSTRIAL WORKERS

In the case of industrial workers much has been said advocating the use of vitamin concentrates to prevent loss of working hours on account of various illnesses, particularly upper respiratory infections. The case of the industrial worker is that of all workers. His nutrition reflects that of the general population living at the same economic level. Certain hazards arise from bad working conditions due to dust, fumes, bad ventilation, bad drainage and inadequate control of temperatures. These can be corrected by well known architectural and engineering practices. There is no information available on the nutritional status of workers or on the pattern of deficiency disease which is apt to develop in a given industry or locality. There is great need for much more extensive and intensive study of particular industries.

various in correlation with reports not only of  
and dietary habits but to the influence of  
which can be interpreted as evidence of  
iciency disease. Calories are essential for  
sustained effort, and the intake must be suffici-  
tly in excess of basal requirements to prevent  
tigue, as much as 300 Calories per hour being  
ed during very heavy work (Booher, 1940).  
der ordinary circumstances the dietary sources  
calories will contain adequate vitamins with  
possible exception of ascorbic acid. The  
quirements for protein remain in some uncer-  
nty. For long an allowance of 1 g. per day  
r lb. bodyweight has been accepted. Recent  
vestigations suggest, however, that active  
ults require from 80 to 120 g. daily (Leitch  
Duckworth, 1937; McCollum et al., 1939).

Controlled studies of the effects of vita-  
ns in increasing the efficiency of workers are  
w and have been concerned only with vitamin A.  
liver oil is reported to have reduced the  
cidence of respiratory infections in a group  
1500 subjects followed during a 5 year period  
olmes et al., 1936). Administration of both  
otene and vitamin A is said to have caused  
rovement in colour vision in persons with poor  
rk adaptation (Wise and Schottler, 1938) and to  
ve accelerated recovery from retinal fatigue  
chettler et al., 1939). The evidence presented  
, however, far from convincing. There is urgent  
ed for further investigation in this field,  
pecially of the possibility of increased require-  
nts for ~~XX~~ B vitamins in men consuming large  
ounts of carbohydrate food. The reputed loss  
large amounts of ascorbic acid in sweat and the  
orted relief of "heat cramps" by ascorbic acid  
quire careful study under controlled conditions  
work and temperature.

In our present state of knowledge, decreased efficiency due to fatigue is best controlled by extra meals of high caloric value taken during working hours. On theoretical grounds these should consist of palatably prepared natural foods rather than sweets or sweetened drinks in which sugar is the sole source of energy. Institution of works canteens serving dietetically well balanced snacks during morning and afternoon "breaks" would seem to be a much better measure than indiscriminate distribution of vitamin pills.

### VITAMIN SUPPLIES IN PREGNANCY AND CHILDHOOD

The effects of malnutrition on pregnant women seem much more subtle than any symptoms or signs which can be detected clinically or any disturbance of metabolism that can be measured in the laboratory. It is only rarely that gross deficiency disease develops during pregnancy, even among the women of a chronically malnourished population. Nevertheless it has been shown that improvement of the nutritional status during pregnancy can reduce maternal morbidity and cause a marked decrease in the incidence of abortion, premature delivery and stillbirth. The most striking results were obtained in the Toronto experiment of Ebbs et al. (1941), in which pregnant women received a liberal dietary supplement of milk, cheese, oranges and canned tomatoes and, in addition, wheat germ, vitamins B1 and D and iron. Toxaemia occurred in only 3.5 percent of a group of 90 women and there were no miscarriages or stillbirths. In the control group of 120 the incidence of toxaemia was 7.6 percent, there were 7 miscarriages and 4 stillborn infants. In the much larger group of about 3000 primiparous women studied in London (People's League of Health, 1942), no supplement of food was furnished but the women took liberal amounts of a preparation of B vitamins, ascorbic acid and vitamins A and D as

Milk, iron, calcium and a mineral mixture containing iodine, manganese and copper. The incidence of toxæmia, as judged by the presence of hypertension or albuminuria, was 27.1 per cent in the treated cases as compared with 31.7 per cent in a control group of equal size. The corresponding values for incidence of prematurity were 20.1 and 23.9.

These results were obtained in times of peace when there were no restrictions on the amounts and varieties of foods obtainable except the money available for their purchase. In war, with animal protein and fats rationed and citrus fruits unavailable for adults, it would seem not only desirable but necessary to make vitamin concentrates, and iron and calcium as well, available to all expectant mothers. Cod liver oil or other sources of vitamins A and D and synthetic ascorbic acid are particularly necessary. The use of wheatmeal bread and potatoes as chief sources of calories makes it unlikely that supplements of the B group of vitamins are generally required.

The present status of children in Britain is probably better than that of any other group of the civilian population. The needs of small children are provided for by the universal distribution of cod liver oil and good sources of ascorbic acid in addition to milk. There may be justification for concern over the ascorbic acid intake of children of school age, particularly during the late winter and early spring. Should there be any evidence of deficiency there should be neither hesitation nor delay in making ascorbic acid universally available for as long a period as necessary. Indiscriminate dosing of children with mixed vitamin concentrates in an effort to prevent upper respiratory infections or for "tonic effect" has no experimental or clinical support.

(Kuttner, 1940). It may in fact do harm by exciting disgust for food.

## POST-WAR SITUATION

The situation in Europe after the war seems certain to present quite different problems and ones which will vary greatly in different countries. The duration of the war obviously will be the determining factor in the relative prevalence of simple underfeeding, famine and vitamin deficiency. The food habits of different nations are also of significance. At present it is not possible to predict the severity or distribution of the deficiencies which will have to be dealt with. Everywhere conditions in cities are likely to be much worse than in rural areas. Observations made in Spain during the civil war of 1936-39 probably foreshadow situations which will be encountered in Western Europe. What may be expected in Poland, Greece and the poorer areas of Rumania can only be surmised. The types of food generally available during periods of severe underfeeding determine the clinical manifestations. In Central Europe during the last 2 years of the first world war, bread was made from very high extraction flour, probably not less than 92 percent and in addition contained varying proportions of rye, barley, beans and potatoes. This bread with potatoes was the chief sources of calories for the civilian population, while cabbages and turnips probably were consumed in larger amounts than any other vegetables. Because the bread and potatoes contained enough of the B group of vitamins to balance the carbohydrate intake, pellagra and other deficiency diseases due to lack of B vitamins were rare. Famine oedema from low protein intake (Maase and Zondek, 1920) and infantile scurvy and rickets were exceedingly common (Dalyell, 1920).

In Madrid almost from the start of the civil war in the summer of 1936 the civilian diet was severely restricted both in quantity and variety

Jimenez Garcia and Grande Cevian, 1940, 1). The daily caloric value is said to have been 500 Calories with some intakes as low as 600 Calories. Bread, lentils, rice, garlic soup and coffee substitutes were the articles regularly available. Occasionally small supplies of meat and vegetables were obtainable. The average composition of the diet was: protein 41.3 g., fat 17.9 g., and carbohydrate 169.6 g. Only one-third of the protein was of good biological value and not more than two-thirds completely digestible. The content of minerals and of vitamins A and C was extremely low; the bread and pulses contributed some vitamins of the B group but not enough to balance the carbohydrate intake over a long period. On this almost incredibly meagre dietary, gross deficiency diseases did not appear for over a year (Jimenez Garcia and Grande Cevian, 1940, 2); probably the very low caloric intake prevented their earlier development. Eventually, diseases due to deficiency of the B group of vitamins became endemic. Peripheral neuropathy, retrobulbar neuritis, simple glossitis and frank pellagra appeared in the order named. Scurvy was rare and famine oedema did not become prevalent until November 1938 after more than two years of extreme privation.

In the Marseilles area during the first half of 1941, Youmans (1942) found no gross deficiency diseases except rickets and anaemia. Dark adaptation was delayed and vitamin A values in the plasma were low in many individuals. There was evidence of regressive desaturation with ascorbic acid and numerous instances of corneal vascularisation were observed. It was, however, extremely difficult to differentiate long standing endemic malnutrition from that which might have developed since the fall of France. The ration in unoccupied France at that time provided approximately 2000 Calories daily. Theoretically it was fairly good from the standpoint of protective foods but actually only basic staple foods were available. Bread was made with 85 parts

of 90% extraction flour and 15 parts of rye, barley, maize and pulses. The bread ration was 270 to 300 per day; meat 60 g., and fat 15 g. daily were permitted but by no means always available. Cheese was rationed at 200 g. per month and milk was generally available for children, pregnant and lactating women and the aged only. Potatoes were rationed and difficult to obtain. All supplies were irregular and food tickets varied in value from time to time.

### FOOD SITUATION IN OCCUPIED EUROPE

There is little definite information on the food situation in occupied Europe at the present time. Official ration lists, such as those issued by the Inter-Allied Information Committee (1942) convey no idea of the availability of rationed foods, and there is no way of estimating what is obtainable outside the ration. There is little doubt that good sources of protein and fat are systematically commandeered by the Germans. Bourne (1942) reviewed the information available early in 1942. At that time in Belgium the bread ration was 55 oz. per week, in Greece 30 oz. Belgium had a potato ration of 1 lb. a day. Fats were limited to  $3\frac{1}{2}$  oz. and meat to  $8\frac{1}{2}$  oz. per week. Occupied France had 4 oz. fat, 9 oz. meat, and  $4\frac{1}{2}$  oz. sugar weekly. Italy, though a member of the Axis, had a bread ration of only 50 oz. a week while the fat was  $3\frac{1}{2}$  oz. and sugar  $4\frac{1}{2}$  oz. In all countries national or local rationing affected cereal products, cheese, milk, poultry, eggs, fish and fruits as well as less important items. The estimated daily calorie values of diets were: in Belgium and Luxembourg 1870, occupied France 2100, Netherlands 2250, and Italy 2500. The most obvious deficiencies are of course in calories and protein of animal origin. It seems certain that food supplies will diminish and highly probable that the Axis nations will increase their requisitions on the occupied areas. All European countries have attempted to keep children and expectant mothers in good

11  
attention by granting priority in protective foods  
by distributing pills containing vitamins  
D and ascorbic acid. Even in Germany, ascorbic  
acid was issued in the spring of 1940 and 1941 to  
infants, schoolchildren, nursing mothers, soldiers  
and sailors. It is evident that even now undernourish-  
ment is widespread. Should the war continue for another  
or 3 years, urban centers are likely to undergo  
starvation comparable with those in Madrid, and it  
is not improbable that many rural areas also will  
suffer severely. There is no doubt that certain  
deficiency syndromes will appear in great numbers  
of people but sheer famine will probably be much  
more important than any of them. Food of any sort  
will be the most urgent requirement and food of  
good quality in ample amounts will probably control  
the ~~more~~ more prevalent manifestations of malnutrition.

The present reviewer cannot add to Bourne's  
forecast that "It is probable that at the end of  
this war the following dietary deficiencies will  
occur to a greater or lesser degree on the continent  
Europe: (1) absolute lack of food; there will  
not be enough food to supply the calorie require-  
ments of the populations; (2) deficiency of protein,  
particularly first class protein; (3) deficiency  
of vitamin D; (4) deficiency of vitamin A; (5)  
deficiency of vitamin C; (6) deficiency of ribo-  
flavin; (7) deficiency of calcium".

The fact that bread made from very high extra-  
ction flour, other cereals, legumes and potatoes  
riches a very high proportion of the calories  
in the diet makes it unlikely that frank pellagrous  
and neuritic syndromes will occur on a large scale,  
except in areas where they smoldered before the  
war. In proportion to the calories consumed, these  
foods furnish fairly adequate quantities of B  
vitamins other than riboflavin. The severe limita-  
tion of fat may change the outlook in this respect  
however. Lack of milk, butter and cheese can be  
expected to cause widespread deficiency of calcium,

of vitamins A and D and of riboflavin, while scarcity of meat contributes to deficiency of riboflavin and nicotinic acid as well as of protein.

It is difficult to amend Bourne's proposals for feeding the people of Europe. He advocated the preparation of adequate stores of wheat, dried skimmed milk powder, dehydrated butter, dried meat and fish and perhaps whale oil and soya bean products. In addition to these, large amounts of vitamin A and D concentrates and either synthetic ascorbic acid or concentrated citrus-fruit juices should be available. These foodstuffs of high quality would relieve famine and furnish satisfactory amounts of protein for rapid cure of famine oedema. Concentrates of vitamins A and D probably will be needed by a majority of children and pregnant women, and ascorbic acid must be available for the treatment of scurvy wherever encountered.

The requirement for synthetic vitamins and concentrates of the B group cannot be foreseen. Treatment of all clinically evident syndromes due to deficiency of these vitamins should be under medical supervision according to whatever plan may be adopted for the study and management of nutritional diseases in Europe. However useful vitamin B1 may be in the treatment of beriberi, or nicotinic acid in the management of pellagra, the use of these vitamins alone for severely depleted patients cannot be recommended. Pellagra has been seen to follow beriberi in patients treated with vitamin B1 only (Lehmann and Nielsen 1939; Salvesen, 1940; Braendstrup, 1940), and has occurred in patients given riboflavin for the cure of angular stomatitis (Bichel and Meulengracht, 1941). Severe beriberi has developed after the administration of nicotinic acid for pellagra (Sydenstricker, 1941) and many instances of riboflavin deficiency have occurred in pellagrins treated only with nicotinic acid (Schmidt and Sydenstricker, 1938). It seems

train that large doses of any one of the three vitamins aimed, though curative for certain definite signs and symptoms, may precipitate major grades of deficiency of one of the others. This statement does not imply that vitamin B1 and nicotinic acid are not life saving in many instances. It is necessary, however, that the large doses of either which are required for the cure of serious illness be accompanied by adequate amounts of the other vitamins of the B complex and particularly by food as large quantities as can be tolerated.

It has been found that when vitamin deficiency superimposed on famine the response of so called "specific signs" to treatment with single vitamins apt to be poor. In Shanghai and Madrid few cures of simple nutritional glossitis and stomatitis were cured with nicotinic acid or any other single vitamin (Kuo and Huang, 1941); (Jimenez Garcia, 1940). Only when yeast or liver extract was added did the signs abate. In the same groups of patients ank pellagrous syndromes were resistant to nicotinic acid until yeast or liver extract was administered (Morris et al. 1940; Grande Covian and Jimenez Garcia, 1940). Since prevalence of the deficiency of particular B vitamins cannot be predicted, it would seem necessary to provide ample supplies of vitamin B1, nicotinic acid and riboflavin but to place their distribution in the hands of adequately trained personnel for administration to patients with clinically evident vitamin deficiencies. Dried brewer's yeast should be available in large amounts, not only for use with the other vitamins in the treatment of patients seriously ill but as a preventive of actual illness in areas where pellagra and perhaps beriberi may be prevalent. Great effort also should be made to secure stores of relatively crude liver extracts which can be given by injection. Many patients are unable to take or retain adequate amounts of dried yeast and for this reason liver extract is more satisfactory than mixtures of synthetic vitamins.

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# THE PRESERVATION OF FOOD

## INTRODUCTORY

Authorities on the dawn of civilization regard as an important step that at which man learned to grow cereals. The importance of this step was twofold. Man produced his food where he wanted it. The food which he produced was capable of storage. No longer had he to forage for it and betake himself to where the food was to be found, no longer need he be a nomad seeking his subsistence now in one place now in another. Not only could man grow his food at his door but, because he grew a food which could be kept, he could also grow it away from his door and, if thought to him, he could then store it. Man had in short defeated both "time" and "space", and it is in terms of "time" and "space" that problems of food preservation and distribution must be considered today.

Such consideration, or to use the current expression, "planning", goes back even on a considerable scale to the remote past. Read the 41st and 42nd chapters of Genesis. Joseph is described as having conceived a seven-year plan for the nutrition of Egypt by storing the harvests of the years of glut for use in the subsequent cycle of famine years. The "corn" was stored at a central depot to which even distant consumers, e.g., Joseph's brethren, came at intervals for supplies. The limit of time was that for which the corn would keep, the limit of space was the competence of the pack beasts of burden.

If this episode in history is looked at with the eyes of one interested in the problems of today, perhaps the point which first arrests the attention is that the planner had something worth storing. Is it not all wheat that will keep satisfactorily for seven years. In the case of

wheat the capability of storage depends in part on the moisture content of the grain and in part on the species. For satisfactory storage the grain should contain not more than 14 percent of water, and with this water content "hard" wheat, e.g., Manitoba, will keep in good condition for at least five or six years before significant deterioration in baking quality occurs. The softer English wheats will not keep so long, but will certainly keep for two years. The keeping time of flour may be taken as being at least a year, provided its water content is below 14 percent. Flour made from good Canadian wheat should keep particularly well, but when English flour, often of high moisture content, is mixed with the Canadian product the flour resulting may contain too much moisture to keep for even six months. There is, of course, to provide drying plant for the increasing crop of English wheat, and this is being done by the miller or in the large central depots.

The first important point with regard to the storage of food is therefore the quality of the original material. Today no less than of yore insistence should be laid on the initial quality of the food stored. The impossibility of making originally bad food into good food by processing it cannot be too strongly stressed, and any attempt to do so should be prevented.

If then the initial quality of the food is granted, the next point for consideration is the length of time that it will keep. Some preserved foods such as "tinned bully beef" will keep almost indefinitely, others such as dried eggs will keep in excellent condition but only for a limited period. Keeping power in terms of time should certainly be known to those responsible for the planning and, in the opinion of the author, it should be known as far as possible to the consumer.

In practice there are certain time intervals which must be observed. One I have already mentioned, namely "indefinitely". Short of the ability for indefinite storage perhaps a period of a year is the longest that is practical. The year as an interval is also dictated by the seasonal production of the majority of articles of diet. A year's storage means that a surplus grown this spring can be used at any time up to next spring. In general, of course, perishable articles are produced in the warmer months and a year's storage means that such articles can be used in the following winter "when things are scarce". But must it be far often that the period of a year applies not only to "crops" but also to such animal products as eggs and milk and indeed herrings. The seasonal nature of production of eggs is evident, that of milk perhaps may be given a word of emphasis, if only because liquid milk is increasingly regarded as a day to day necessity. Considered in terms of time, the day is the limit from the consumers' point of view. To the country an adequate and approximately equal amount of milk should be served out every day of the three hundred and sixty-five. But the day is by no means the limit from the producers' point of view. Whether you consider the quality of the milk or the quantity (and the nutritive value is the product of the two) the peak tends to be at the time when the grass is growing, i.e., in the late spring and summer.

In terms of time then, consumption takes place at a uniform rate whilst production tends to be cyclical, and perhaps the most important cycle is the year. In the case of perishable food such a condition lends itself immediately to waste. If enough food has to be produced on the day of least production to satisfy the consumer, then the excess in the periods of greater production tends to be wasted. In the case of milk, if the dairies must supply enough fresh milk in the first of January

to meet the needs of the country, what is to become of the great excess produced on the first of June? That excess must either be wasted or in some way or other be processed. In Northern Ireland alone 13,000,000 gallons of milk are produced in "summer" in excess of the milk drunk during that season. The time honoured ways of processing milk are of course turning its ingredients into butter and cheese. Butter, however, only preserves a single energy giving constituent, the fat, and that not in a form which lasts very long at ordinary temperatures. Cheese in theory is more satisfactory but even so the whey protein, milk sugar and minerals may be wasted.

Now let us turn from the consideration of time to that of space. The outstanding fact is that as the world becomes more industrialised so the consumer becomes separated by greater distances from the place where his food is produced. I have attributed the divorce of the consumer from the producer to industrialisation, to the assembly of large numbers of people in towns and, in the wider sense, of great populations in countries small but rich in mineral ores, countries such as Belgium and Britain. That perhaps stated the case before 1939 but the devastation of war has added in full measure to the separation in space of consumer from producer. Whole countries whose populations amount in the aggregate to tens if not hundreds of millions will at the end of the war be stripped. Their cattle will have vanished and in consequence their power of producing both milk and protein will have become inadequate. Their land will have deteriorated for want of fertilisers, whether natural or artificial, the machinery and implements of their farms will have disappeared and their manual labour will have waned for want of physical strength. For a decade, to the normal necessity for moving foodstuffs over large distances from the producer to the consumer, there must be added a wholly abnormal need for

transporting the elementary necessities of subsistence. Nor is this all; at the very time when extra food for transport is becoming imperative to save whole populations, the machinery for shifting commodities is being destroyed as a primary object of military strategy. We do not know what fraction of the refrigerated tonnage of the world will be available at the end of the war. Public statements by responsible persons suggest that were the war to end tomorrow there would be less ordinary tonnage by many million tons than in 1939. What is true of marine tonnage is true, though perhaps to a less extent, of the paraphernalia of road and rail transport. Engines are being "shot up" and worn out whilst engine shops build munitions of war. Trucks are wearing out and lorries are being diverted to military uses from which they will only in small measure return.

What then is the nature of the problem which confronts us? It is threefold:

- 1) To produce food of the best initial quality in those places where it can be produced.
- 2) To preserve it over a year or more, with the least detriment to its nutritive qualities.
- 3) To pack it in such a way that it will make the least demand in tonnage.

To the solution of this threefold problem I will address myself.

### INITIAL QUALITY

The first division into which the problem falls might be regarded as fittingly as deciding the scope of an article on the preservation of foods.

Yet may not the preserver demand the best possible raw material? And even at the risk of making a slight digression I can scarcely avoid putting in a plea for raising the efficiency of the farm as a source of food. It may seem a little cold to regard the cow as a machine for processing and concentrating the nourishment in grass so that it may subserve the sustenance of mankind, but can I be blamed if I enter a plea for a more scientific outlook when I see a herd of a couple of hundred beautiful cows whose milk production is reduced to only half of what it should be by causes in one way or another secondary to the tubercle with which the animals are infected, and yet they are not eating significantly less pasture? The National Veterinary Medical Association have calculated that extermination of the major infections in cattle would, on approximately the present pasture, give Great Britain 200 million additional gallons of milk in the year, or a pint weekly for every man, woman and child of the population.

Fortunately we are awaking to the need of improvement in our produce, not only of the milk producing potentiality of our herds, but of the caloric value of our potatoes, the vitamin value of our carrots and a host of other things. We are beginning to wake up, but we are only beginning.

### KEEPING PROPERTIES

Let me pass to the methods of processing foods, considering them rather from the standpoint of keeping quality.

The processing of foods in one way or another is of course a very old industry, many instances of foods preserved by methods which have come down from our ancestors will come to mind, bacon, jam kippers, salt cod, corned beef and so forth. Today, however,

it be the aim of the processor to produce a product which will keep over a year, the major part of dealing with the fresh material are:

- (a) refrigeration,
- (b) canning,
- (c) drying,

(a) Refrigeration.

It is not my purpose here to discuss the relative merits of different methods of refrigeration, as, for example, the pros and cons of chilling as compared with freezing. Some years ago it was commonly taught that chilled beef, in contrast with frozen beef, would only keep a few weeks, long enough to tide it over the journey from the Argentine but not long enough to suffice for the voyage from Australia. Gas storage in the refrigerated colds has largely invalidated this teaching and has extended the lifetime of chilled beef. With a broader outlook, however, it is possible, by the application of sufficient cold, to keep eminently perishable foodstuffs in excellent condition. To take an extreme case, sole has been kept at the Ferry Research Station at Aberdeen at  $-30^{\circ}\text{C}$  for at least four years in such excellent state as to be indistinguishable on the table from the very freshest fish, and distinguishable from sole, as ordinarily served, by reason of its apparent freshness. Nor is there any reason to suppose that the nutritive value of the sole was impaired by its long and extreme refrigeration. In a general way there is no reason to suppose that refrigeration affects the nutritive value of meat. From frozen liver, it is true, enzymes are liberated which have deleterious effect on vitamin C, but meat is not eaten primarily for the purpose of supplying the body with vitamins; other articles of diet should be relied upon for these. Meat is eaten primarily for the purpose of feeding the body with protein and

fat, neither of which is impaired by refrigeration. Considered with regard to fat, the weak point about refrigeration is not that it destroys the fat but that it only protects it to a limited degree. The deterioration of fatty tissue is due to one or both of two causes, oxidation and microbial decomposition. The former affects the fat itself, the latter involves perhaps first the connective tissue which forms the skeleton of the fatty tissue and then indirectly the contained fat. Deterioration in either case produces an unpleasant flavour. Neither oxidation nor microbial decomposition is stopped dead by mere chilling; their actions are, however, so greatly delayed as to preserve the meat for some weeks. At  $-10^{\circ}\text{C}.$ , however, microbial action ceases and, at temperatures below that, oxidation becomes extremely slow. For this reason it has become the practice in some of the American refrigerating plants to store meat, poultry, fish, butter and cream at temperatures as low as zero of the Fahrenheit scale ( $-18^{\circ}\text{C}.$ ).

The rate of deterioration of adipose tissue depends not only on the temperature but upon the nature of the fat itself and that is dictated by the species. Beef and mutton keep longer than pork and bacon, which in turn lend themselves more readily to refrigeration than rabbit. The more highly saturated the fats, the less is their tendency to oxidise.

The effect of refrigeration on proteins is less simple than on fats. Food proteins are of course in aqueous solution and when the temperature is reduced to below the freezing point of water the tendency is for the water to freeze, forming ice, and for the material in solution to be thrown out. This catastrophe is mitigated by another tendency working in the opposite direction, that of super-saturation.

In the case of mere ~~whittling~~ alteration of state, as far as is known, in either the chemical or physical state of the protein and therefore it can be said straight away that there is no drop in its nutritive value. In the case of freezing what will happen depends really upon the particular protein involved and the properties, such as solubility, of the aqueous medium in which the protein is dissolved. Haemoglobin, for instance, in aqueous solution undergoes no change if frozen to  $-10^{\circ}\text{C}$ . and thawed. Egg protein once reduced to that temperature thaws out to something obviously different from the original material. Even in the case of egg protein, however, there is no reason to suppose that the alteration makes the protein less nourishing.

As far as meat is concerned there is no ground for supposing that the nutritive value of the protein is impaired by refrigeration. The question as in the case of fats, is to what extent cold will really prevent the malign processes which would otherwise make for the putrefaction of the meat. Of these the most important are microbial; while it cannot be claimed that any portion of the carcase is immune from them, it is obvious that the responsible microbes are for the most part those which assail the surface of the carcase after the animal is slaughtered. Refrigeration can in no wise be regarded as a process which renders cleanliness unnecessary. On the other hand, it cannot be emphasised too strongly that cleanliness and refrigeration are complementary, the one to the other. When the carcase comes to be dealt with in some land perhaps 10,000 miles from where the animal was slaughtered, its condition will depend not only on the temperature at which it has travelled but upon the meticulousness of the conditions under which the animal was killed and its carcase dressed and trimmed, and on the

promptness with which all the processes up to that of refrigeration were carried out.

Passing from meat to vegetables, we must remember that the vitamin value of these is a matter of importance and on this subject I can only quote Dr. L. J. Harris (1938):

"Of the papers so far published concerning the effects of refrigeration on the vitamin content of foods, the majority deal with vitamin C. Two main points seem to stand out:

- 1) In many instances the amount of the vitamin preserved appears to be proportional to the extent of the lowering of the temperature. But it would seem that with certain materials, e.g., especially with fruit juices, a less intense degree of cooling is necessary. Detailed information as to the optimum conditions for different types of products has still to be worked out.

- 2) Apart from its beneficial effect in preserving the vitamin, freezing may have a deleterious action in breaking up the cells of the foodstuffs and setting free oxidative enzymes which attack the vitamin as soon as thawing occurs. There is a promise that procedures may be worked out which will obviate this last difficulty".

#### (b) Canning.

Among the virtues possessed by canned commodities the outstanding one is long life. As far as the gross proximate principles of food are concerned, canned meat should keep indefinitely, vegetables perhaps five years and fruits at least a year; some fruits keep longer.

Instances can be given of canned foods which seem to have been preserved in tolerable condition

For a very long time. For instance, "Two cans have been traced which were left by Parry on the expedition when the ship was lost. They were brought back unopened by Hogg. They found their way into the Museum of Shipwreck at Pickering Hall, Hull, in all probability because it was a Hull sailor, Tinsell, who picked up Hogg and his party in an unpowered craft in an open boat in 1833.

"One canister contained pea soup and the other beef. Apparently they were both opened about 60 years ago in 1911, the cans being 87 years old, when the contents were found to be in excellent condition. It is reported that a meal was made of them without ill effects. A small portion of both soup and meat were preserved in formalin and are now shown in the museum together with the tins" (Drummond and Lewis, 1939).

Two other tins, one of veal and one of carrots, from Parry's expedition (1824) have been opened recently and analysed the most interesting feature of the analysis, apart from the general excellence of the contents, was that the veal tin still contained quantities of vitamin D of the same general order as, though somewhat less than, that in a fresh veal control. The lumps of veal were in a gravy thickened with starch and this latter seemed to be responsible for a few pathogenic spore bearing organisms still capable of cultivation in air. The carrots also were in good condition. Here it may be stressed that the efficient preservation of tinned foods depends more on the quality of the tins than on the quality of the material tinned and the methods of closing them.

In dealing with the preservation of vegetables raised in the open air it is possible to obtain all the necessary vitamins from

a diet of canned and bottled foods. We have already seen that vitamin D stands up to canning. Vitamin C is present in satisfactory amounts in canned black currants, grape fruit and tomatoes, as it also is in concentrated orange and grape fruit juices. Canned carrots and green vegetables would contribute vitamin A, but vitamin B, more especially B<sub>1</sub>, is a more difficult proposition and there the problem is how to protect a vitamin which under some circumstances is destroyed by heat. The answer, so far as there is an answer, centres on the fact that the destruction of vitamin B<sub>1</sub> on heating is related to the alkalinity or otherwise of the material cooked. In making bakers' bread the dough is on the acid side of normal, a circumstance which makes for the preservation of vitamin B<sub>1</sub>, and it is possible to make biscuits in a similar way. Riboflavin, also in the germ of wheat, is not broken down by heat, but information is lacking about the quantities of the other factors of the vitamin B complex in canned foods.

If, therefore, to canned and bottled foods are added cereals containing a sufficiency of B vitamins (i.e., porridge, wholemeal bread, or biscuit in which the vitamin has not been subjected to alkali) it seems difficult to put one's finger on a reason for supposing that these foods cannot form the basis of a highly nutritious diet, and this is borne out by the results of feeding experiments.

### (c) Drying.

Let us pass from canning to drying, which again is not a new process. In "Historic Tinned Foods" Drummond and Macara (1939) reproduce a photograph of a cake of portable soup originating from c.1771. They analysed a fragment and gave the following verdict: "The material seems to be

was prepared from meat and bones. It does not appear to have undergone any marked change during 100 years." In view, however, of the great amount of research which has been carried out in recent years on dried foods, and of the obvious possibility which may present itself in the future of producing dried foods from other materials, it is well to mention this as a possibility.

It should also be made to put forward a preliminary statement of the merits of dried foods which have been kept over long periods of time but a good deal can be said about periods up to a year. By "dried" or "dehydrated" or "desiccated" foods, I mean foods which in the natural state contain considerable quantities of water, from which the water has been abstracted, and to which it is added again before the food is set on the table. In general the reconstitution of the food will take the form of soaking, or of steaming over night and then boiling for half an hour as in the case of the relatively refractory carrot, or of merely pouring on boiling water which, with stirring, reconstitutes potatoes rather into mashed potato in a matter almost of seconds. There are, however, foods such as some dried fruits for which soaking in cold water will suffice.

This is perhaps the place to say a word about milk. There are two outstanding ways of drying milk known technically as "roller drying" and "spray drying". In the former the milk films on paper or is picked up by rollers heated internally by steam under pressure to the appropriate temperature, and the water evaporates from the film of milk forming on their surface; in the latter, after pasteurisation and some degree of concentration, the milk is projected as a fine spray into a large funnel shaped chamber where it meets

a blast of hot air. The droplets lose their water and the dried milk falls as a powder on to the sides of the chamber down which it slides. Milk dried by the former method is widely used for baby food, but the latter method has certain advantages if the milk is for general use in place of fresh milk. "Household milk" is a dried separated milk, that is, milk from which the cream has previously been removed. It has great merits for cooking and is a rich source of protein and of calcium, but it cannot provide such nutritive elements as depend upon the presence of the fat.

The keeping properties of milk may be viewed from two standpoints, that of flavour and that of vitamin content. The principal cause of deterioration in flavour is reaction of the fat with oxygen of the air. If there is no deterioration in flavour it may be assumed that as far as protein, carbohydrates and fat are concerned the milk is good, for in presence of oxygen the fat is the least stable of the three. Good spray dried milk, if packed in such a way as to preclude the action of oxygen, should after more than a year taste as good as fresh pasteurised milk.

I use the phrase "preclude the action of oxygen" advisedly. Two ways of doing this may be mentioned, packing the milk powder in tins containing nitrogen instead of air or compressing the powder into a solid block.

As regards vitamins, tests of spray dried milk powder packed in nitrogen have been carried out over 16 months at temperatures higher than any to which milk powder is likely to be subjected continuously in any part of the world. As regards vitamin A, there was no falling off during either drying or storing and the same was true of carotene and riboflavin; as regards vitamin B<sub>1</sub>.

there was a falling off of 10 percent in the first, while 20 percent of ascorbic acid was lost in storage. I.e., the so-called 'old powder' contained over 70 percent of the vitamin B<sub>1</sub> in the fresh milk. The greatest falling off was in vitamin C, of which 20 percent was lost on drying and 30 percent of the remainder was lost on storage, so that the powder contained just about one half of the original vitamin C. At ordinary temperatures the deterioration was even less.

Before leaving milk a word may be said about its flavour. It seems probable that the flavour of milk may be modified in two ways; first, it may lose its natural characteristic flavour, thus getting what is termed a "flat taste", and second, it may acquire a rancid taste by the oxidation of the fats. It is not unimportant to note that, so far as our knowledge of milk goes, the flavour is a very good index of its nutritional excellence, and indeed this principle may be stretched beyond milk.

Quite apart from the mere appeal to the palate, indeed, a double importance attaches to the preservation of the flavour in the processing of food; in the first place, as indicated above, if the flavour is preserved there is presumptive evidence of the excellence of the food and, in the second place, the appeal which the diet makes to the palate goes a long way towards the promotion of its digestion.

It may be said for dehydrated foods of the best quality that, when reconstituted, they are extremely attractive. Shepherd's pie, for instance, made from dried meat and dried potatoes, might reasonably challenge that made from fresh constituents and is better than the shepherd's pie obtainable at most restaurants. As regards children, a large test was performed in the Royal Air Force in which 400 men were divided into two groups; to one

was given reconstituted dried cabbage, to the other boiled fresh cabbage. The men, of course, were not aware of being the objects of the test. The group which had the dried cabbage left less on their plates than did the other, moreover the vitamin C content of the cooked dried cabbage was greater than that of the cooked fresh cabbage. The last statement needs a word of explanation in that neither contained as much vitamin C as fresh cabbage, but less vitamin C was lost in the process of precooking, drying and re-cooking, than in the ordinary process of boiling.

The drawback about dried foods at present is that in order to be dried efficiently their surface must be very large in proportion to their bulk. Nature has conferred this property on the cabbage, not so on the beef steak and the haddock. Therefore, for the present methods of dehydration by drying in hot air, meat and fish must be minced. The meat products therefore are restricted to such as can be made from mince, and the fish to fish cakes and the like.

What the future may have in store we do not know; giving meat a large surface can in theory be accomplished by "ice drying", by freezing the meat and removing the crystals of ice which permeate it by sublimation in vacuo. This process is only in its infancy as far as the mass preservation of the staple articles of diet is concerned.

Before leaving the subject of the preservation of dried foods, I should like once more to stress quality. The science of drying has reached a point at which the food can be dried to a specification. There seems little reason why, if the State chose to require that food should be of a given standard of quality, the standard in the case of dried foods should not be stated on the packet and exacted. For this at least I should put in a

place and the date of the more perishable food commodities, those whose lifetime is of the general order of a year, dried and for instance, the date before which the commodity should be consumed should be stamped on the packet.

## TRANSPORTABILITY

Now let us pass from considerations of "time" to those of "space". To what extent can the preservation of food facilitate its removal from the site of the producer to that of the consumer?

Briefly, just as the outstanding merit of canning is longevity, so that of drying is transportability. The saving in weight, space and storage capacity and the increase in flexibility and convenience is such that a very short survey will suffice for their demonstration. This survey may be undertaken commodity by commodity.

Before starting that survey let me say that to the process of drying has been added another, that of compressing the dried material into compact blocks. This "blocking" process does not save weight but it has other merits; firstly, it saves space, secondly, it makes for a reduction in the demand for tin plate, and thirdly, if complete, it reduces the surface of food exposed to the air to that of the superficial area of the block with a corresponding reduction in the opportunity for oxidative changes. As has already been said, powdered whole milk is packed in tins containing nitrogen but blocked whole milk powder, not specially packed, has been brought from Australia, through the tropics, in non-refrigerated cargo space and kept already for more than a year without serious deterioration.

The above sentence is intended to show the great advantages of canning and drying over chilling

and freezing, namely that, whereas refrigerated material requires not only to be transported but also to be stored, till near the time of its consumption, in a refrigerated atmosphere, canned and dried foods may travel on any ship or any train and be stored in any place.

Now let us survey some important commodities.

Meat. In the case of refrigeration much space and weight may be saved by boning the meat before it starts on its journey. Table I will give the reader an idea of the relative facility of transporting meat in different forms.

TABLE I. Meat

Side of beef	R* or N*	Wt. in lb.	Cubic feet occupied
Untreated	R	150	6.3
Boned	R	112	3.5
Tinned	N	120	2.6
Dried & blocked	N	44	1.0

\* R = refrigerated. N = non-refrigerated.

In the above comparison, the blocked, dried meat has less than one-third of the original weight and occupies less than one-sixth of the bulk. To this immediate saving must be added that of the weight of, and the space occupied by, the refrigerating plant, to say nothing of the overhead and working expense of refrigeration and the inconveniences of being tied to refrigerated ships, trucks and stores.

Fish. One hundredweight of fish will dry down to 11 to 16 lb. according to the nature of the

product, i.e., according to the amount of waste included. Thus the actual product is reduced to one-fifth of the weight of 1935, and this again does not take account of the saving in weight and bulk which, if fish is transported in ice, is brought by not having to shift the ice.

Vegetables. The figures in Table II show the saving in weight and space by drying and blocking cabbage.

TABLE II. Cabbage

Cabbage		Weight in lb.	Cubic feet occupied
Fresh	..	25	1.56
Trimmed	..	14	0.9
Dried, loose	..	1	0.2
Dried, blocked..		1	0.03

The cabbage is, therefore, reduced to one-twenty-fifth of its original weight and to one-fiftieth of its volume.

Eggs. In the case of eggs the saving in weight and bulk is given in Table III.

TABLE III. Eggs.

360 Eggs.		Weight in lb.	Cubic feet occupied
In shell	..	57	2.4
Powdered	..	11	0.4
Blocked	..	11	0.24

Thus, when powdered and blocked, the eggs are reduced to one-fifth of the weight and take up but one-tenth of the volume of shell eggs. This does not of course include the saving in wrapping.

Milk. The figures in Table IV may be regarded as average figures.

TABLE IV. Milk

One quart milk	Weight in oz.	Cubic inches occupied
Fresh	41	69
Evaporated (a form of condensed)	16.8	27.2
Dried powder	5.3	15.6
Blocked	5.3	7.7

Thus, as compared with the fresh milk, canned milk (condensed) weighs between one-half and one-third, and the reduction in volume is in about the same proportion, but the blocked powder weighs only one-seventh and occupies one-ninth of the bulk of the original milk.

### CONCLUSION.

After this brief survey may we look back and epitomise what has been accomplished in the thousands of years since the pioneer in Egypt made his 'seven-years' plan' for the local distribution of a single commodity?

Firstly, it is possible now to preserve in a number of ways a variety of articles of diet so considerable as to form practically a complete dietary.

Secondly, it is possible to preserve some of them over a lifetime and a great many over a time long enough to prevent the waste which might occur from ordinary seasonal surpluses. I use the word "surpluses" rather than "gluts" advisedly. The

The "glut" is used to denote variously: a seasonal surplus, a greatly excessive seasonal surplus but not recurring in a place which is to the extent of a lifetime, i.e., an exceptionally good year, and as in a glut of herrings, an enormous plethora in a place and at a time neither of which is predictable. The application of the principle of preservation to these three sorts of glut increases progressively in difficulty. The nature of the difficulties involved becomes at once apparent to any person who faces the question. For the first two sorts of perishable commodities and the plans for preserving them to be brought into distribution? It is for the "planner" to explain, if he can, how the third type of glut can be made an economically sound proposition. Short of being economically sound, there is the possibility that, rather than waste the food, the expense of its utilisation should be carried by other and less risky operations.

Thirdly, drying and blocking have brought a reduction in weight and bulk which, in conjunction with transport by aeroplane, enables the most necessary articles of diet, such as milk, to be transferred to almost any population from some part of the world where they can be produced in bulk. The weight of bombs dropped on the Ruhr in May as given in the daily press was 8800 tons. This weight of dried milk would yield 4,000,000 pints of liquid milk a day for 31 days, about half a pint for every head of the population in a country the size of Belgium or Portugal. As regards the cost, according to figures quoted by Peter Massfield (Sunday Times, 30th May 1943), after the war the cost of transport by air for 600 miles should be about four pence per pound. In terms of dried milk this would mean that, for a cargo of dried milk unloaded in Europe, the further cost of carriage by air to any place

within 600 miles of the port of entry would be a little more than  $\frac{1}{2}$  d. per pint of the reconstituted milk.

Science has been blamed for rendering possible many of our ills, but in the processing of foods it has surely much to show on the side of good. If at the end of the war the housewife cannot reduce the number of times she need go to shop, if she cannot put in her shopping bag several times its present complement of nourishment, if the cabinet minister cannot utilise a given tonnage for the transport of much greater quantities of the essentials of life, if the State cannot promote wellbeing by the prevention of waste and the saving and utilisation of surpluses wherever possible, it will not be the fault of science, rather will it be the fault of the planner.

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